The New York State Cardiac Registries: Description of Reporting Systems and Overview of Associated Research

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Outline

- History of Systems and Efforts to Assure Complete and Accurate Data
- Description of Methods Used to Calculate Risk-Adjusted Mortality
- Description of Annual Reports and Other Information Supplied to Providers
- Examples of Studies Based on NYS Cardiac Databases

History of NY's CSRS/PCIRS

- **Developed in Conjunction with NYS Cardiac Advisory Committee**

- **Developed As a Result of Frustration in Using Aggregate Data to Assess Hospital Quality**

New York's CSRS/PCIRS

- **Created in 1989/1992 for purposes of:**
  - **Improving quality of Open Heart Surgery**
  - **Feeding back information on outcomes and risk factors to hospitals and operators**
  - **Public dissemination of information on risk-adjusted outcomes**

Data Collection Process

- Data Entered in Web-Based Data Entry System by Hospital Cardiac Surgery Departments

- Forwarded to DOH for Data Quality Checks and Analysis

Data Quality Assurance

- **Completeness Checked Using DOH Admin. Data**
- **Mortality Compared with DOH Admin. Data**
- **Sample of Medical Records Audited by DOH's Utilization Review Agent**

Data Quality Assurance, Cont'd.

- These data quality audits are absolutely essential in assuring the highest possible accuracy of provider outcome assessments

- Hospitals chosen for audit on the basis of random choice, time since last audit, previous reporting problems, risk factor reporting frequencies

Assessment of Risk-Adjusted Mortality

- For Each Provider, a risk-adjusted mortality rate is calculated by adjusting for a variety of risk factors that are related to survival
- Risk-adjusted mortality rate: what the provider's rate would be if all providers had the same case mix
- A provider's RAMR is calculated by comparing the ratio of its observed and expected mortality rates, where the expected mortality rate is based on a statistical model that uses patient risk factors to predict mortality using the statewide experience

Assessment of Risk-Adjusted Mortality

- **RAMR = (OMR/EMR) SMR ,**
  where RAMR= Risk-Adjusted Mortality Rate and SMR= Statewide Mortality Rate

- **The EMR is the mean of the individual predicted probabilities of mortality from the statistical model**

Expected Mortality Rate

- These come from a formula that weighs the individual risk factors each patient has

- $P=1/(1+e^{-(b_0+b_1x_1+\ldots+b_nx_n)})$

  where the x's are the risk factors and the b's are their weights that come from the statistical model

Uses of System for Quality Assurance/Quality Improvement

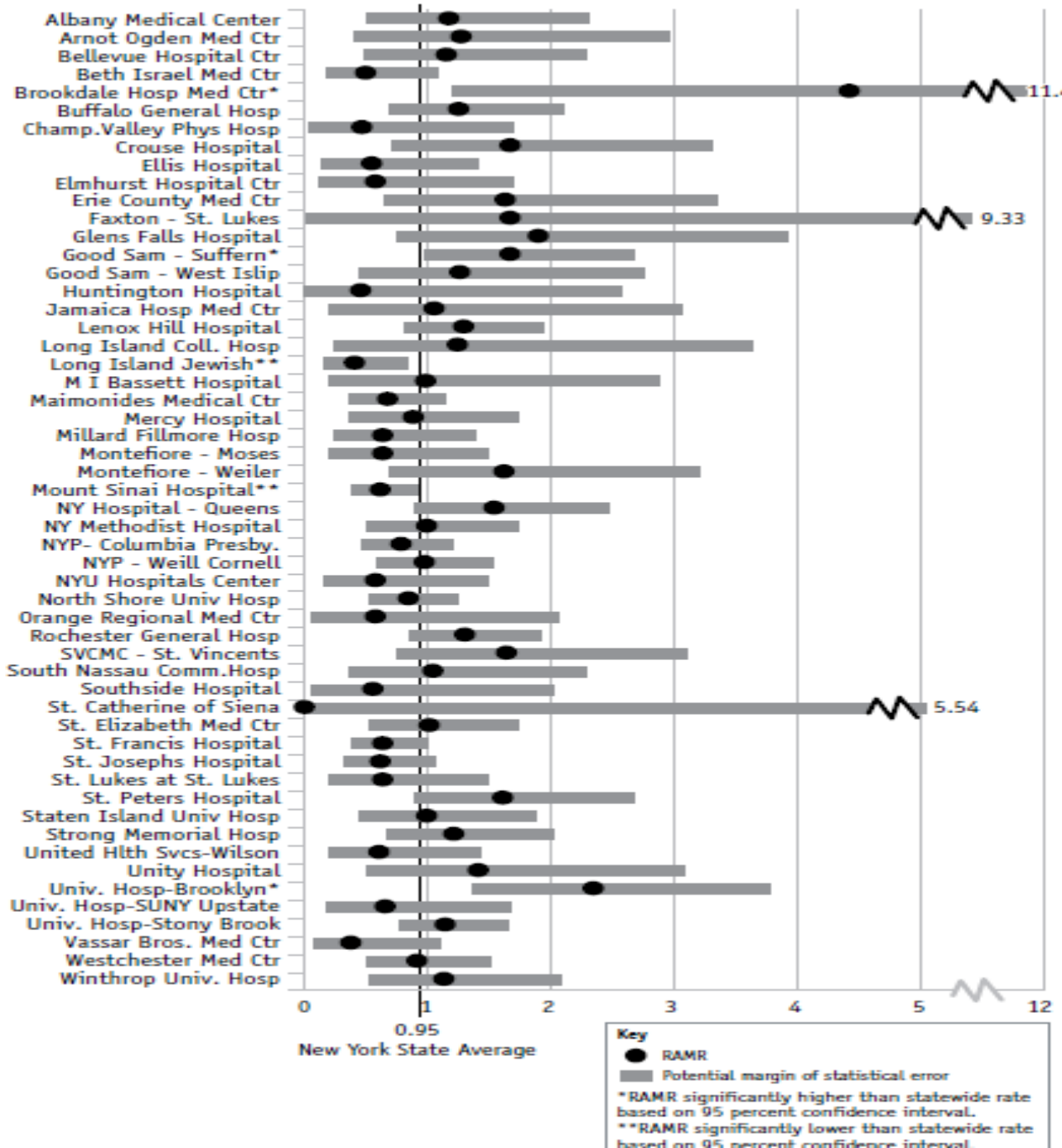
- Annual public reports detailing mortality and risk-adjusted mortality
- Reports fed back to hospitals describing how they compare with other hospitals on various patient subgroups
- Alert letters to hospitals during course of year so they can identify problems as quickly as possible
- Information on relationship between processes and outcomes

Appendix 1 Multivariate Risk-Factor Equation for In-Hospital/30 Day Deaths During or Following PCI, 2008 (All Cases)

Patient Risk Factor	Prevalence (%)	Logistic Regression		
		Coefficient	P-Value	Odds Ratio
Demographic				
Age: number of years > 55	---	0.0537	<.0001	1.055
Hemodynamic State				
Unstable	0.44	2.1129	<.0001	8.272
Ventricular Function				
Ejection Fraction				
Ejection Fraction 40% or greater	88.97	---Reference---		1.000
Ejection Fraction less than 20 %	0.81	1.2760	<.0001	3.582
Ejection Fraction 20-29 %	3.46	0.9310	<.0001	2.537
Ejection Fraction 30-39 %	6.77	0.4659	0.0005	1.593
Pre-Procedural MI				
No MI within 20 days	74.22	---Reference---		1.000
MI with ST Elevation:				
MI < 12 hours	9.15	2.1499	<.0001	8.584
MI 12-23 hours	1.04	2.0925	<.0001	8.105
MI without ST Elevation				
MI < 6 hours	0.57	1.7430	<.0001	5.715
MI 6-23 hours	2.04	1.1030	0.0002	3.013
MI with or without ST Elevation				
MI 1-7 days	11.57	1.1328	<.0001	3.104
MI 8-20 days	1.41	0.9382	0.0003	2.555
Comorbidities				
CHF, Current	5.44	0.6136	<.0001	1.847
COPD	6.40	0.9363	<.0001	2.550
Malignant Ventricular Arrhythmia	0.61	1.1034	<.0001	3.014
Renal Failure				
No Renal Failure	68.42	---Reference---		1.000
Renal Failure, Creatinine 1.2-1.5 mg/dl	21.71	0.2556	0.0265	1.291
Renal Failure, Creatinine 1.6-2.5 mg/dl	6.81	0.7747	<.0001	2.170
Renal Failure, Creatinine > 2.5 mg/dl	0.92	0.8790	0.0022	2.408
Renal Failure, Requiring Dialysis	2.15	1.8751	<.0001	6.521
Vessels Diseased				
Three Vessels Diseased	13.72	0.4196	<.0001	1.521
Left Main Disease	3.87	0.3601	0.0341	1.433

Intercept = -6.9437
C Statistic = 0.859

Figure 1 In-Hospital/30-Day Risk-Adjusted Mortality Rates for PCI in New York State, 2008 Discharges (All Cases)



CABG Surgery: Using Process/Outcomes Link to Improve Quality of Care and Outcomes

- (1) Find link between processes and adverse outcomes
- (2) Feed back information on effective processes to providers
- (3) Use effective processes to improve outcomes

CABG Surgery: Using Process/Outcomes Link to Improve Quality of Care and Outcomes

- **Suggested Process Measures in the Literature Include:**
  - **Use of IMA grafting**
  - **Temperature Control**
  - **Hematocrit control**

  The relationships between outcomes and these processes were studied using NYS data

Criticisms of Public Dissemination

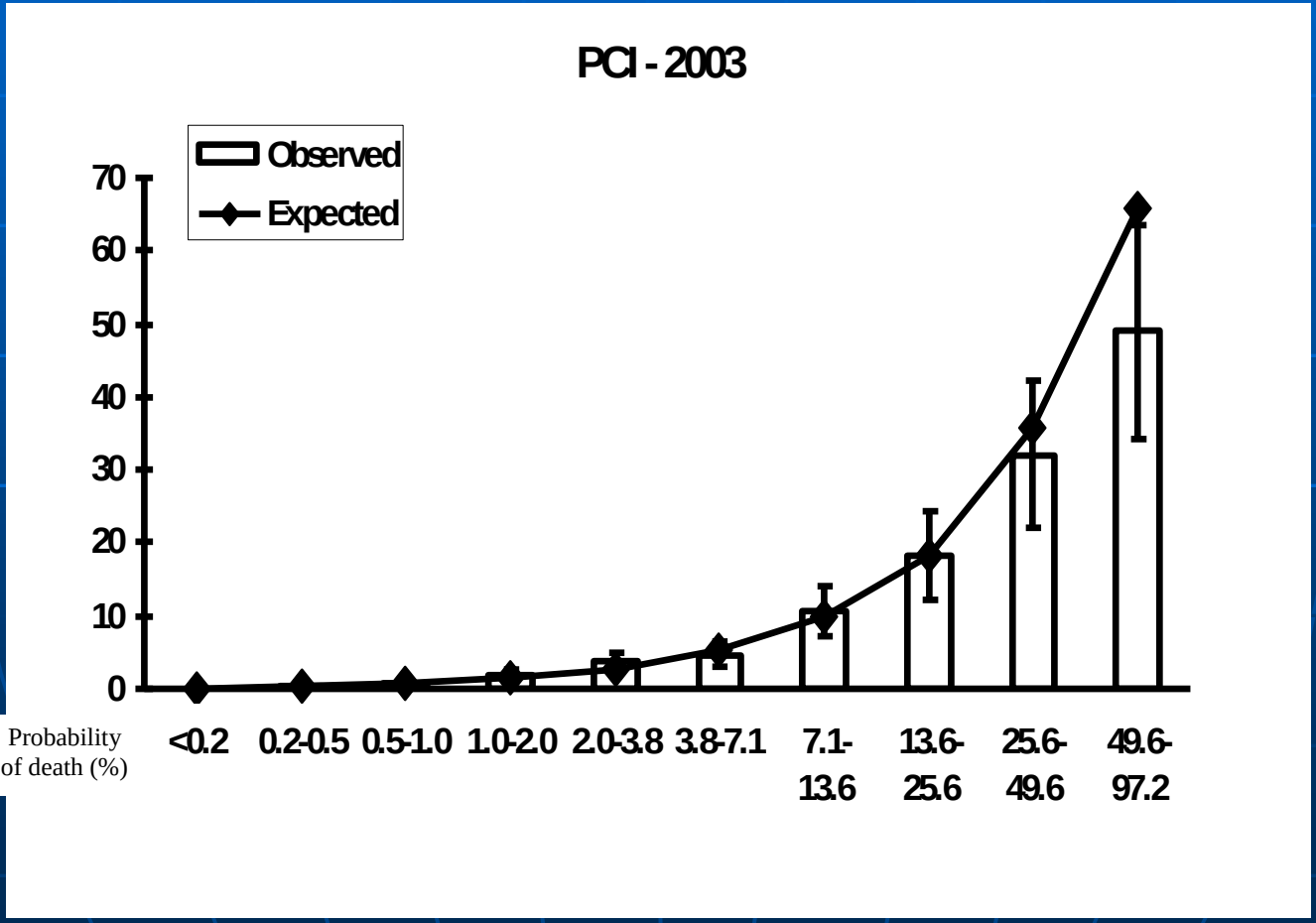
- **Inaccurate risk adjustment leading to avoidance of high risk cases**
- **Gaming the system to overestimate patient risk**

High-Risk Cases

- **Obviously, the purpose of the risk-adjustment is to "even the playing field" by lowering risk-adjusted mortality for providers with sicker patients**

- **Question: Is this done well enough so that providers are not disadvantaged on average by treating higher risk patients?**

PCIRS Database: Observed vs. Expected Rates for Different Ranges of Expected Mortality Rate



Performance (RAMR) on Shock vs. Non-Shock Cases: Hospitals

- **Crude Mortality Rate for All PCI Pts. in NY in 2003: 0.58%**
- **Note: Risk-adjusted rate for entire group of shock cases is exactly 0.58%**
- **For shock, OMR =33.8% and EMR=33.8%**
- **Performance on shock cases by hospital**
  - **16 with no cases**
  - **18 with RAMRs below hospital's overall RAMR**
  - **11 with RAMRs above hospital's overall RAMR**

PCIRS Data:2001-2003 Hospital Performance With and Without Shock Cases

- Year 2001-2003 Outliers for all PCI Cases

- 2001 1 High, 1 Low
- 2002 0 High, 0 Low
- 2003 2 High, 0 Low

- Note: If all shock cases are taken out of the database, these outliers remain exactly the same

Performance (RAMR) on Shock vs. Non-Shock Cases: Operators

Performance on shock cases by operator

- **159 with no cases**
- **84 with RAMRs below operator's overall RAMR**
- **59 with RAMRs above operator's overall RAMR**

PCIRS Data:2001-2003
Operator Performance With and Without Shock Cases

- **Outliers in 2001-2003:**

  7 High, 5 Low

- **Note: If all shock cases are taken out of the database, these outliers remain exactly the same**

Policy Change Regarding Shock Patients

- **As of 2006, shock cases have no longer been publicly reported; the following table shows the number of shock cases in the registry in the PCI registry just before and ever since that decision**

Number of cases and in-hospital/30-day deaths with shock or unstable in PCIRS 2005 – 2010.

	N	%	Dth	OMR
Shock				
2005#	83	0.15	28	33.73
2006	133	0.23	56	42.11
2007	146	0.28	63	43.15
2008	138	0.25	70	50.72
2009*	156	0.28	71	45.51
Unstable				
2005#	281	0.50	60	21.35
2006	252	0.43	41	16.27
2007	251	0.48	41	16.33
2008	246	0.45	66	26.83
2009*	247	0.45	56	22.67

#Shock exclusion policy instituted in 2006.
*OMR = Observed In-Hospital(only) Mortality Rate for cases with risk

NY Versus US Changes in CABG Surgery Mortality

- The overall CABG mortality rate declined by 28% among NY Medicare pts. between 1989 and 1992[1]
- The overall mortality rate declined by 13% among US Medicare pts. between 1989 and 1992[1]
- NY CABG mortality declined significantly faster ($p<.01$).[1]

1 Peterson et al., The Effects of New York State's Bypass Surgery Provider Profiling on Access to care and Patient Outcomes in the Elderly, JACC 1998;32:993-9).

NY CABG Mortality vs. US: Continued

- NY had lowest CABG mortality rate in country in 1992
- NY was among top 3 in mortality rate decrease between 1989 and 1992

NY CABG Mortality vs. US: More Recently: 1994-1999

Provider Profiling and Quality Improvement Efforts in CABG Surgery: The Evidence from Medicare Data

Medical Care 2003;41(10):1164-1172

Hannan EL, Sarrazin MSV, Doran DR, Rosenthal GE

- Context: In the last decade, a few states or regions in the United States have initiated efforts to publicly disseminate coronary artery bypass graft (CABG) surgery outcomes and/or formally initiate quality improvement programs for CABG surgery.

- Objective: To compare CABG mortality rates and changes in CABG mortality rates in regions with quality improvement/public dissemination efforts with the remainder of the country (NY, PA, NJ, NNE, NEOH)

- **Design, Setting and Patients:**

  Medicare data from 1994-1999 were used to develop a logistic regression model that predicts patient mortality for CABG surgery on the basis of pre-operative patient risk factors and region of the country.

Results:

- The odds ratio for risk-adjusted mortality for the 6-year period in all study regions combined was significantly lower (OR=0.79, 95% CI, (0.73-0.85)) than in the remainder of the US.

- The odds ratio was also significantly lower for each year and for the 6-year time period in New York (OR = 0.66, 95% CI, (0.57-0.77)) and Pennsylvania (OR = 0.79, 95% CI, (0.73, 0.86)).

- The change in risk-adjusted mortality between 1994 and 1999 remained essentially constant for all regions except New Jersey, the only region to initiate their program during the study period, which exhibited a significant reduction in risk-adjusted mortality after the introduction of their Registry.

Adjusted Odds Ratios for Medicare CABG Surgery Mortality Relative to Remainder of the United States** : 1994-1999

Year	All Regions with QI Programs	Northern New England	Northeastern Ohio	New Jersey	New York	Pennsylvania
1994	0.81* (0.73-0.89)	0.95 (.80-1.14)	1.02 (.79-1.31)	0.90 (.77-1.05)	0.64* (.53-.78)	0.85* (.74-.98)
1995	0.80* (0.73-0.88)	0.71* (.56-.89)	0.86 (.69-1.08)	1.04 (.92-1.17)	0.72* (.58-.88)	0.79* (.71-.88)
1996	0.86* (0.78-0.94)	0.97 (.73-1.28)	0.89 (.59-1.35)	1.15 (.96-1.39)	0.74* (.61-.90)	0.82* (.74-.91)
1997	0.77* (0.69-0.85)	0.87 (.68-1.13)	0.72* (.53-.97)	0.90 (.66-1.23)	0.65* (.55-.77)	0.81* (.70-.92)
1998	0.74* (0.66-0.84)	1.04 (.79-1.36)	1.15 (.74-1.78)	0.87 (.66-1.14)	0.59* (.48-.72)	0.70* (.62-.80)
1999	0.74* (0.66-0.82)	0.99 (.67-1.45)	0.72 (.52-.99)	0.77* (.64-.94)	0.64* (.53-.77)	0.76* (.66-.90)
Total	0.79* (0.73-0.85)	0.92 (.76-1.11)	0.89 (.67-1.17)	0.94 (.82-1.09)	0.67* (.57-.77)	0.80* (.73-.87)

*95% Confidence Intervals for Adjusted Odds Ratios
** For States/Regions with Quality Improvement Efforts

Prevalence of Risk Factor in 1999 in % (Percentage Increase from 1994 to 1999)

Risk Factor/Region	Remainder of the US	Northern New England	Northeastern Ohio	New Jersey	New York	Pennsylvania
Age 80 and Over	15.8 (63.6)	13.9* (57.9)	17.2 (132.4)	18.8* (111.6)	18.4* (65.3)	17.3* (100.8)
Principal Dx = Myocardial Infarction	20.4 (7.2)	20.3 (11.1)	17.7* (42.7)	21.4 (-0.7)	21.3* (10.4)	23.5* (19.7)
Emergent Type Admission	24.8 (-12.7)	31.9* (-11.9)	37.1* (0.3)	22.1* (-12.9)	38.3* (26.3)	34.1* (-15.9)
Admission Through Emergency Room	18.8 (-8.3)	13.2* (0.0)	15.6* (33.3)	12.0* (23.7)	17.0* (-3.4)	19.4 (26.8)
Two or More Comorbid Conditions	13.9 (14.9)	11.3* (-1.7)	17.8* (38.0)	15.8* (29.5)	12.1* (11.0)	14.8* (61.7)
Congestive Heart Failure	18.4 (1.7)	14.6* (-15.6)	24.5 (36.9)	23.6 (11.9)	18.7 (3.9)	21.1* (8.2)
Female	34.8 (2.7)	34.5 (-0.8)	34.6 (0.0)	35.7 (10.2)	32.7* (-3.5)	38.9 (12.1)

*** $p < 0.05$ when compared to the remainder of the US**

Out-of-Region CABG Surgery (%) by Residents of Region in 1994 and 1999

Percentage/ Region	Remainder of the US	Northern New England	Northeastern Ohio	New Jersey	New York	Pennsylvania
1994 Percentage	10.5	15.2#	6.5#	23.4#	9.9	4.9#
1999 Percentage	10.5	12.6#	6.9#	18.4#	10.4	4.9#
Change (%)	0.0	-17.1*	+6.2	-21.5*	5.5	0.0

*** p < 0.05 for comparison of % out of region in 1994 and 1999**

 # p < 0.05 for comparison of out-of-region percentage to remainder of US

Conclusions Regarding NY's CABG System

- Mortality of CABG Surgery has decreased tremendously in NY, seemingly at least in part because of the dissemination of outcomes[3]
- Mortality reduction has not been accomplished by shifting of patients to hospitals with better outcomes[4]
- The impact of surgeon volume on mortality has decreased somewhat, although it is still important[5]

3 Hannan EL, Kilburn H, Lindsey ML et al.., Improving the Outcomes of Coronary Artery Bypass Surgery in New York State. JAMA 1994;271:761-766

4 Hannan EL, Kumar D, Racz M, et al., New York State's Cardiac Surgery Reporting System: Four Years Later. ATS 1994;58:1852-1857

5 Hannan EL, Siu AL, Kumar D, et al., The Decline in Coronary Artery Bypass Graft Surgery in New York State: The Role of Surgeon Volume. JAMA 1995;273:209-213

- There is no compelling evidence that 'appropriate" high-risk patients are losing access to CABG surgery[2,6] (as evidenced by changes in risk profile or by transfers out-of-state)
- There is evidence of several quality improvement initiatives having been undertaken
- The advantage in risk-adjusted mortality relative to the country expanded tremendously during the first five years and has remained constant since then[2]

2 Hannan EL, Sarrazin MSV, Doran DR, Rosenthal GE. Provider Profiling and Quality Improvement Efforts in CABG Surgery: The Effects on Short-Term Mortality Among Medicare Beneficiaries, Medical Care, 2003;41(10):1164-1172.

6 Hannan EL, Siu AL, Kumar D, et al., Assessment of CABG Surgery Performance in NYS: Is There a Bias Against Taking High-Risk Patients? Medical Care 1997;35:49-56.

Examples of Other Studies Related to Quality of Care Measures and Comparative Effectiveness Research

CABG Risk Score

Risk Stratification of In-Hospital Mortality for Coronary Artery Bypass Graft Surgery

Journal of the American College of Cardiology, 2006;47(3):661-668.

Hannan EL, Wu C, Bennett EV, Carlson RV, Culliford AT, Gold JP, Higgins RSD, Isom OW, Smith CR, Jones RH. Risk Stratification of In-Hospital Mortality

Table 2. Risk scores for in-hospital mortality for CABG*

Risk Factor	Score	Risk Factor	Score
Age		Pre-procedural Myocardial Infarction (MI)	
61 – 69 Years	1	MI < 6 Hours	5
70 – 79 Years	3	MI 6-23 Hours	4
80 Years and Older	5	MI 1 – 20 Days	1
Female Gender	2	Chronic Obstructive Pulmonary Diseases	1
Hemodynamic State		Extensively Calcified Ascending Aorta	2
Unstable	2	Peripheral Vascular Disease	2
Shock	5	Renal Failure Requiring Dialysis	5
Ejection Fraction		Previous Open Heart Operations	3
Ejection Fraction < 20%	4		
Ejection Fraction 20 – 29%	3		
Ejection Fraction 30 – 39%	2		

* Range of total score, 0 – 34.

Table 3. Predicted risk of in-hospital mortality associated with individual risk scores; and the distribution of total risk score among CABG patients in New York State in 2002 (N=16,120).

Total Risk Score	Predicted Risk (%)	Cumulative Percentage of Patients with This Risk Score or Less (%)	Total Risk Score	Predicted Risk (%)	Cumulative Percentage of Patients with This Risk Score or Less (%)
0	0.30	12.00	12	20.22	99.12
1	0.43	25.88	13	26.86	99.46
2	0.62	34.69	14	34.72	99.70
3	0.90	52.03	15	43.52	99.84
4	1.29	60.31	16	52.74	99.92
5	1.86	73.78	17	61.78	99.94
6	2.67	81.44	18	70.07	99.97
7	3.82	88.18	19	77.23	99.99
8	5.45	92.78	20	83.09	99.99*
9	7.70	95.66	21	87.68	99.99*
10	10.78	97.57	22+	> 90	100.00
11	14.90	98.51			

* The highest observed total risk score was 22; and there were no patients who had total risk scores of 20 and 21 in 2002 data.

Adherence of Catheterization Laboratory Cardiologists to ACC/AHA Guidelines for Percutaneous Coronary Interventions and CABG Surgery: What Happens in Actual Practice?

Circulation 2010;121:267-275.

Hannan EL, Racz MJ, Gold J, Cozzens K,
Stamato NJ, Powell T, Hibberd M, Walford G.

Background:

The American College of Cardiology (ACC) and the American Heart Association (AHA) have issued guidelines for the use of coronary artery bypass graft surgery (CABG) and percutaneous coronary interventions (PCI) for many years, but little is known about the impact of these evidence-based guidelines on referral decisions.

Methods:

A cardiac catheterization laboratory database used by 19 hospitals in New York State was used to identify treatment (CABG surgery, PCI, medical treatment, nothing) recommended by the catheterization laboratory cardiologist for patients undergoing catheterization with asymptomatic/mild angina, stable angina, and unstable angina/non-ST-elevation myocardial infarction (NSTEMI) between 1/01/05 and 8/31/07. The recommended treatment by the cath lab cardiologist was compared with indications for these patients based on ACC/AHA guidelines (using Class I and Class II criteria).

Indications and Recommendations

- **Indications: combination of 2001 and 2005 PCI indications from ACC/AHA guidelines; 2004 ACC/AHA CABG guidelines**
  - **Class I: evidence or general agreement that procedure is effective**
  - **Class IIa: weight of opinion/evidence is in favor of usefulness or efficacy**
- **Recommendations based on cath. lab cardiologist (source of final rec. 64% of the time)**

Table 1: ACC/AHA Indications vs. Catheterization Laboratory Recommendations, New York, 1/01/05-12/31/07. Indications for ACC/AHA Class I and Class IIa Regarded as Equal.

ACC/AHA Indication/ Cath. Lab Recommendation	CABG (%)	PCI (%)	Medical Treatment (%)	None (%)	Total
CABG	311 (50)	207 (34)	89 (14)	9 (1)	616 (100)
PCI	42 (2)	1,667 (89)	161 (9)	7 (<1)	1,877 (100)
CABG & PCI	20 (4)	489 (93)	15 (3)	1 (<1)	525 (100)
Neither CABG Nor PCI	61 (9)	109 (17)	475 (72)	11 (2)	656 (100)
Total	434 (9)	2,472 (67)	740 (20)	28 (<1)	3,674 (100)

Table 2: ACC/AHA Indications vs. Catheterization Laboratory Recommendations, New York, 4/01/06-8/31/07. Hospitals with Catheterization Laboratories and PCI/CABG (Full-Service Hospitals)

ACC/AHA Indication/ Cath. Lab Recommendation		CABG (%)	PCI (%)	Medical Treatment (%)	None (%)	Total
CABG		129 (38)	152 (44)	60 (17)	3 (<1)	344 (100)
PCI		11 (1)	1,143 (93)	74 (6)	3 (<1)	1,231 (100)
CABG & PCI		5 (1)	376 (97)	6 (2)	1 (<1)	386 (100)
Neither CABG Nor PCI		13 (3)	82 (17)	370 (78)	8 (2)	473 (100)
Total		158 (6)	1,753 (72)	510 (21)	15 (<1)	2,436 (100)

Conclusions

- Most pts (89%) indicated for PCI were recommended for PCI
- Most pts (93%) indicated for PCI and CABG were recommended for PCI
- A high percentage (34%) of patients indicated for CABG were recommended for PCI; this rose to 52% when Class I was regarded as superior to Class IIa; it varied from 18% to 44% for cath-only hospitals to PCI/CABG hospitals.
- Patients with coronary artery disease receive more recommendations for PCI and fewer recommendations for CABG surgery than is indicated in the ACC/AHA guidelines.

Thirty-day Readmissions Following CABG Surgery in New York

in press, JACC: Cardiovascular Interventions

Hannan EL, Zhong Y, Laheh SJ, Culliford AT, Gold JP, Smith CR, Higgins RSD, Jordan D, Wechsler A

Table 1. Observed and Risk-Adjusted 30-day Readmission Rate Related To Index CABG for Hospitals

Number of Hospitals	40
Observed Readmission Rate	
Mean	0.14
Median	0.14
Range	0.08-0.21
Risk-Adjusted Readmission Rate	
Range	0.09-0.22

Pearson Correlation Coefficient between Observed and Risk-Adjusted Readmission Rate: $r=0.97 (P<0.0001)$

Table 2. Principal diagnosis for readmissions related to index CABG

Principal diagnosis	Number	Percentage (%)
Postoperative Infections	751	16.9
Heart Failure	570	12.8
Other Complications of Surgical and Medical Care	434	9.8
Cardiac Dysrhythmias	280	6.3
Angina Pectoris and Chest Pain	208	4.7
Pleural Effusion and Atelectasis	181	4.1
Pneumonia	176	4.0
Postcardiotomy Syndrome	166	3.7
Atherosclerosis	154	3.5
Myocardial Infarction and Ischemia	114	2.6
Sepsis and Bacteremia	111	2.5
Other Diseases and Symptoms of the Nervous System	105	2.4
Pulmonary Embolism and Infarction	100	2.2
Ulceration, Bleeding and Perforation of the Digestive System	94	2.1
Hypertension and Hypotension	87	2.0
Stroke	80	1.8
Acute Respiratory Failure	63	1.4
Cellulitis	60	1.3
Dehiscence and Rupture of Operation Wound	58	1.3
Acute Renal Failure	55	1.2
Other Diseases and Symptoms of the Respiratory System	51	1.1
Hemorrhage and Hematoma Complicating a Procedure	50	1.1
Pericarditis, Endocarditis and Myocarditis	49	1.1
Venous Embolism and Thrombosis	46	1.0
Infection due to Device, Implant and Graft	44	1.0
Others	358	8.1
Total	4445	100.0

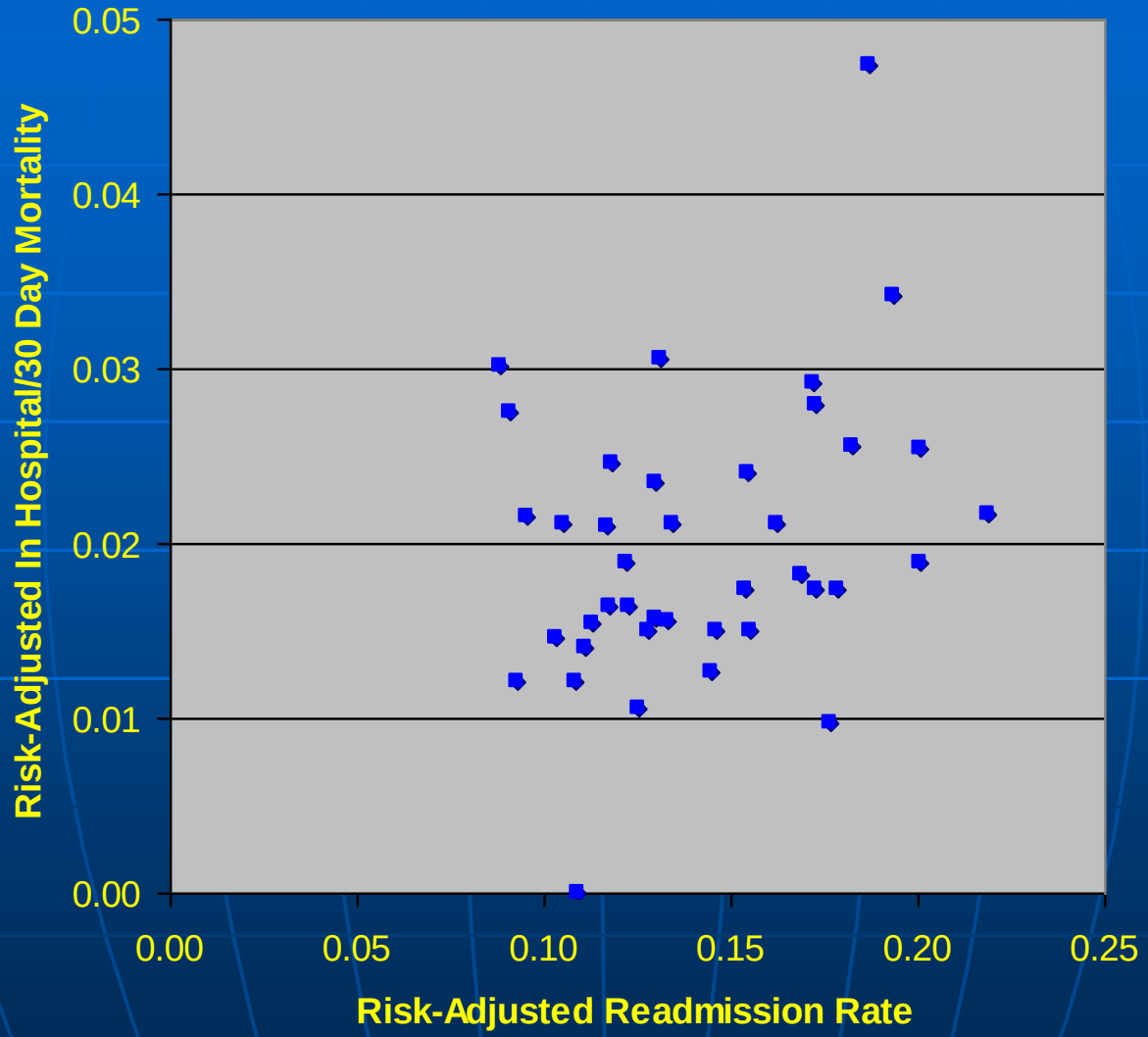
Table 3. Risk Factors Related to Readmission Within 30 Days of CABG Surgery (N = 30953)

Variables	%	Coef	OR	P-value
Patient Characteristics				
Age: # of years > 70	--	0.0047	1.03 (1.02, 1.04)	<.0001
Female	26.46	0.0255	1.25 (1.19, 1.31)	<.0001
African American	7.23	0.0701	1.16 (1.01, 1.33)	0.0344
BMI m^2				
Not Obese: ≤ 30	62.86		1.00	
Obese Class I: 30.1-34.9	23.71	0.0422	1.12 (1.03, 1.22)	0.0071
Obese Class II: 35-40	8.98	0.0490	1.25 (1.14, 1.38)	<.0001
Obese Class III: over 40	4.44	0.0677	1.56 (1.37, 1.78)	<.0001
Preoperative Risk Factors				
Cerebrovascular Disease	19.30	0.0328	1.12 (1.05, 1.20)	0.0005
Peripheral Vascular Disease	12.65	0.0526	1.19 (1.07, 1.32)	0.0009
Shock	0.23	0.4218	1.92 (0.84, 4.40)	0.1206*
CHF	10.84	0.0593	1.25 (1.11, 1.40)	0.0002
COPD	19.92	0.0341	1.35 (1.26, 1.45)	<.0001
Extensive Aortic Atherosclerosis	6.39	0.0520	1.18 (1.06, 1.30)	0.0017
Diabetes	35.71	0.0412	1.18 (1.09, 1.28)	<.0001
3-vessels diseased	51.13	0.0256	1.07 (1.01, 1.12)	0.0123
Immune System Deficiency	2.31	0.0899	1.42 (1.19, 1.69)	<.0001

Variables	%	Coef	OR	P-value
Preoperative Risk Factors (cont.)				
Previous PCI Before this admission	19.05	0.0459	1.10 (1.01, 1.21)	0.0314
Ejection Fraction Less than 30%	7.80	0.0652	1.17 (1.03, 1.33)	0.0143
Renal Failure				
No renal failure and Creatinine: ≤ 2.5	96.6		1.00	
Creatinine: > 2.5	1.46	0.1439	1.41 (1.06, 1.87)	0.0174
Dialysis	1.94	0.1417	1.53 (1.16, 2.02)	0.0025
Postoperative Complications				
Deep Sternal Wound Infection	1.03	0.1263	7.24 (5.65, 9.27)	<.0001
Renal Failure	0.77	0.1223	1.50 (1.18, 1.91)	0.0008
Unplanned Cardiac Reoperation	0.59	0.1553	1.68 (1.24, 2.28)	0.0008
Other Risk Factors				
IMA Grafting This Visit	92.68	0.0686	0.82 (0.72, 0.94)	0.0040
LOS				
<=4 days	27.69		1.00	
5-6	37.64	0.0510	1.30 (1.18, 1.44)	<.0001
7-10	23.79	0.0548	1.66 (1.49, 1.84)	<.0001
11-15	6.07	0.0695	1.69 (1.48, 1.94)	<.0001
>15	4.80	0.0808	1.84 (1.57, 2.16)	<.0001

* Shock became not significant after applying GEE to adjust for within-hospital correlation

Figure 1. Hospital Risk-Adjusted Readmission Rate vs. Hospital Risk-Adjusted In Hospital/30 Day Mortality



Pearson Correlation Coefficient: r=0.32(P=0.0466)

Original Article

Drug-Eluting Stents vs. Coronary-Artery Bypass Grafting in Multivessel Coronary Disease

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Background

- **Numerous studies have compared outcomes of two competing interventions for multi-vessel coronary artery disease-coronary artery bypass graft (CABG) surgery and coronary stenting. However, little information is available since the introduction of drug-eluting stents (DES).**

Databases

- **Primary databases: New York State registries for all patients undergoing CABG surgery and PCI in non-federal hospitals. They contain data on demographics, risk factors, and in-hospital outcomes. and are linked by patient IDs to get subsequent revascularizations**

- **Other databases:**

Vital statistics data for deaths after discharge

Acute care discharge data for readmissions with MI

Methods

- **Databases: CSRS and PCIRS, 10/31/03-12/31/04 Linked to Vital Statistics Data through 2005**
- **Patients: NY residents with multi-vessel disease who underwent stent implantation or CABG surgery with no LM disease, previous revascularization, or MI within 24 hours**
- **7,437 CABG pts. and 9.963 DES pts.**

Methods, Continued

- Vital Statistics data were used to capture survival, and CSRS and PCIRS were used to identify subsequent revascularization; outcomes were risk-adjusted to account for differences in patients' demographics and severity of illness

- Outcomes examined:
  - Risk-adjusted mortality and mortality/MI within 18 months (using Cox Proportional Hazards Model)
  - Subsequent revascularization within 18 months

Risk Factors in Patients Treated with CABG or Drug-Eluting Stents

Table 1. Risk Factors in Patients Treated with CABG or Drug-Eluting Stents.*

Risk Factor	CABG (N=7437)	Stent (N=9963)	P Value
Age (%)			<0.001
<50 yr	7.6	9.7	
50–59 yr	20.7	23.1	
60–69 yr	30.2	27.6	
70–79 yr	31.3	26.9	
≥80 yr	10.2	12.7	
Median age (yr)	67.0	66.0	<0.001
Mean age (yr)	66.0±10.9	65.4±11.9	<0.001
Sex (%)			<0.001
Male	72.5	67.2	
Female	27.5	32.8	
Hispanic ethnic background (%)†	6.9	9.3	<0.001
Race (%)†			<0.001
White	87.7	82.1	
Black	7.1	10.1	
Other	5.2	7.9	
Ejection fraction (%)			<0.001
<20%	2.0	0.8	
20–29%	6.8	3.3	
30–39%	12.9	6.6	
≥40%	77.7	84.2	
Data missing	0.6	5.1	
Previous myocardial infarction (%)			<0.001
1–7 days before treatment	20.5	18.9	
8–20 days before treatment	5.6	2.5	
≥21 days before treatment	21.4	12.3	
No previous myocardial infarction	52.5	66.3	
Cerebrovascular disease (%)	17.3	7.7	<0.001
Peripheral arterial disease (%)	10.7	7.0	<0.001
Hemodynamic instability or shock (%)	1.8	0.2	<0.001
Congestive heart failure (%)			<0.001
None	84.3	89.9	
At current admission	12.6	7.4	
Before current admission	3.1	2.7	
Malignant ventricular arrhythmia (%)	0.7	0.4	0.03
Chronic obstructive pulmonary disease (%)	17.4	6.6	<0.001
Diabetes (%)	38.2	32.7	<0.001
Renal failure (%)			0.01
Requiring dialysis	2.2	2.4	
Creatinine >2.5 mg/dl (220 μmol/liter)	2.0	1.4	
No renal failure	95.8	96.3	
No. of diseased vessels (%)‡			<0.001
3, with proximal LAD artery	51.5	11.8	
3, without proximal LAD artery	18.4	13.1	
2, with proximal LAD artery	20.0	26.1	
2, without proximal LAD artery	10.1	49.0	

* Plus–minus values are means ±SD. Because of rounding, percentages may not total 100. CABG denotes coronary-artery bypass grafting, and LAD left anterior descending.
† Race or ethnic group was reported by the Cardiac Surgery Reporting System and the Percutaneous Coronary Intervention Reporting System registries.
‡ Diseased vessels were defined by the presence of stenosis of at least 70%.

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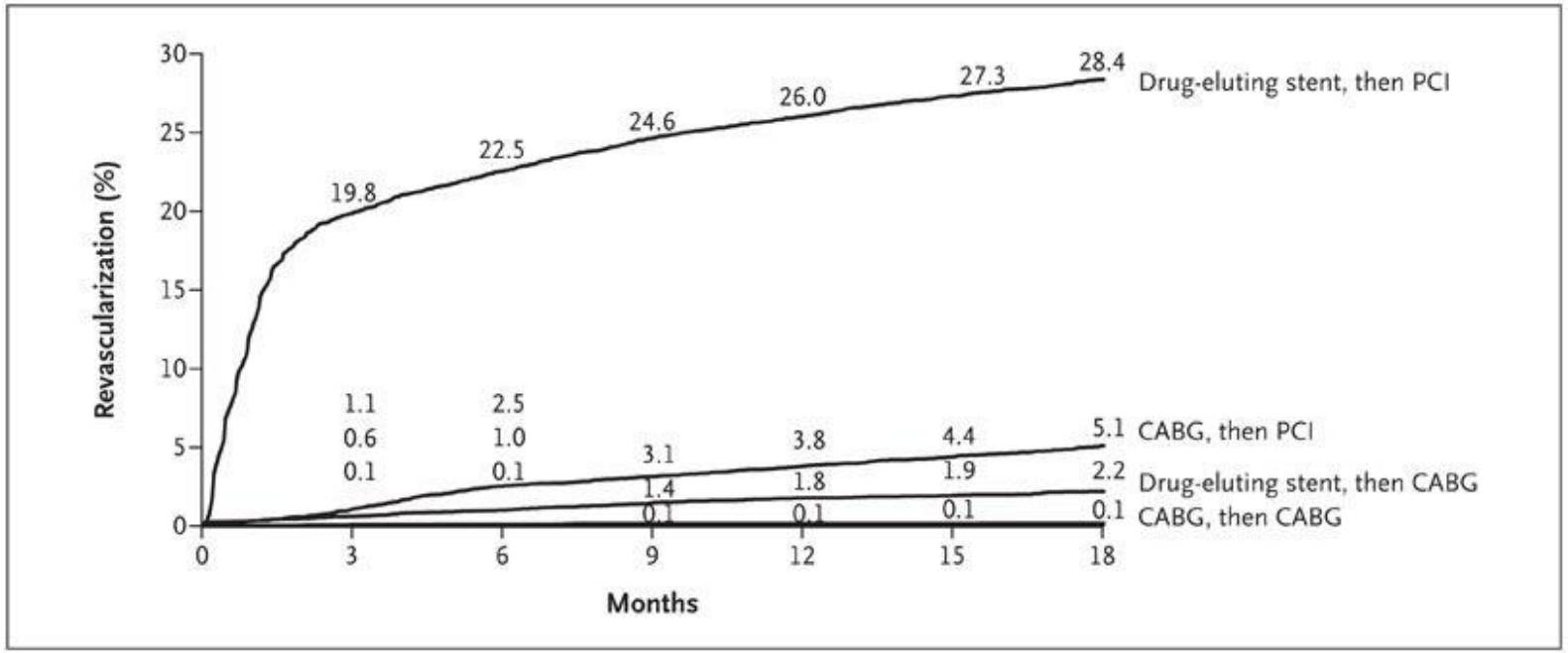
Rates of Revascularization within 18 Months after Initial Procedure



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Hazard Ratios for Death and for Death or Myocardial Infarction after CABG and after Treatment with a Drug-Eluting Stent, According to Number of Diseased Vessels

Table 2. Hazard Ratios for Death and for Death or Myocardial Infarction after CABG and after Treatment with a Drug-Eluting Stent, According to Number of Diseased Vessels.*

Variable	No. of Patients	Mean Follow-up	Death			Death or Myocardial Infarction		
			No. of Events	Adjusted Hazard Ratio (95% CI)†	P Value	No. of Events	Adjusted Hazard Ratio (95% CI)†	P Value
		mo						
3 Diseased vessels								
With or without proximal LAD artery								
CABG	5202	19.1	346	0.80 (0.65–0.97)	0.03	449	0.75 (0.63–0.89)	<0.001
Stent	2481	18.5	171	Reference		249	Reference	
With proximal LAD artery								
CABG	3833	19.1	257	0.79 (0.61–1.02)	0.07	331	0.77 (0.61–0.96)	0.02
Stent	1178	18.5	85	Reference		117	Reference	
Without proximal LAD artery								
CABG	1369	19.1	89	0.79 (0.58–1.09)	0.15	118	0.69 (0.53–0.91)	0.008
Stent	1303	18.5	86	Reference		132	Reference	
2 Diseased vessels								
With or without proximal LAD artery								
CABG	2235	19.2	118	0.71 (0.57–0.89)	0.003	156	0.71 (0.59–0.87)	<0.001
Stent	7482	18.7	397	Reference		555	Reference	
With proximal LAD artery								
CABG	1486	19.2	80	0.71 (0.53–0.96)	0.02	105	0.72 (0.56–0.93)	0.01
Stent	2600	18.6	143	Reference		201	Reference	
Without proximal LAD artery								
CABG	749	19.1	38	0.69 (0.48–0.98)	0.04	51	0.71 (0.52–0.96)	0.03
Stent	4882	18.8	254	Reference		354	Reference	

* CABG denotes coronary-artery bypass grafting, and LAD left anterior descending.
† Hazard ratios are adjusted for age; sex; ejection fraction; hemodynamic state; history or no history of myocardial infarction before procedure; presence or absence of cerebrovascular disease, peripheral arterial disease, congestive heart failure, chronic obstructive pulmonary disease, diabetes, and renal failure; and involvement of the proximal LAD artery.

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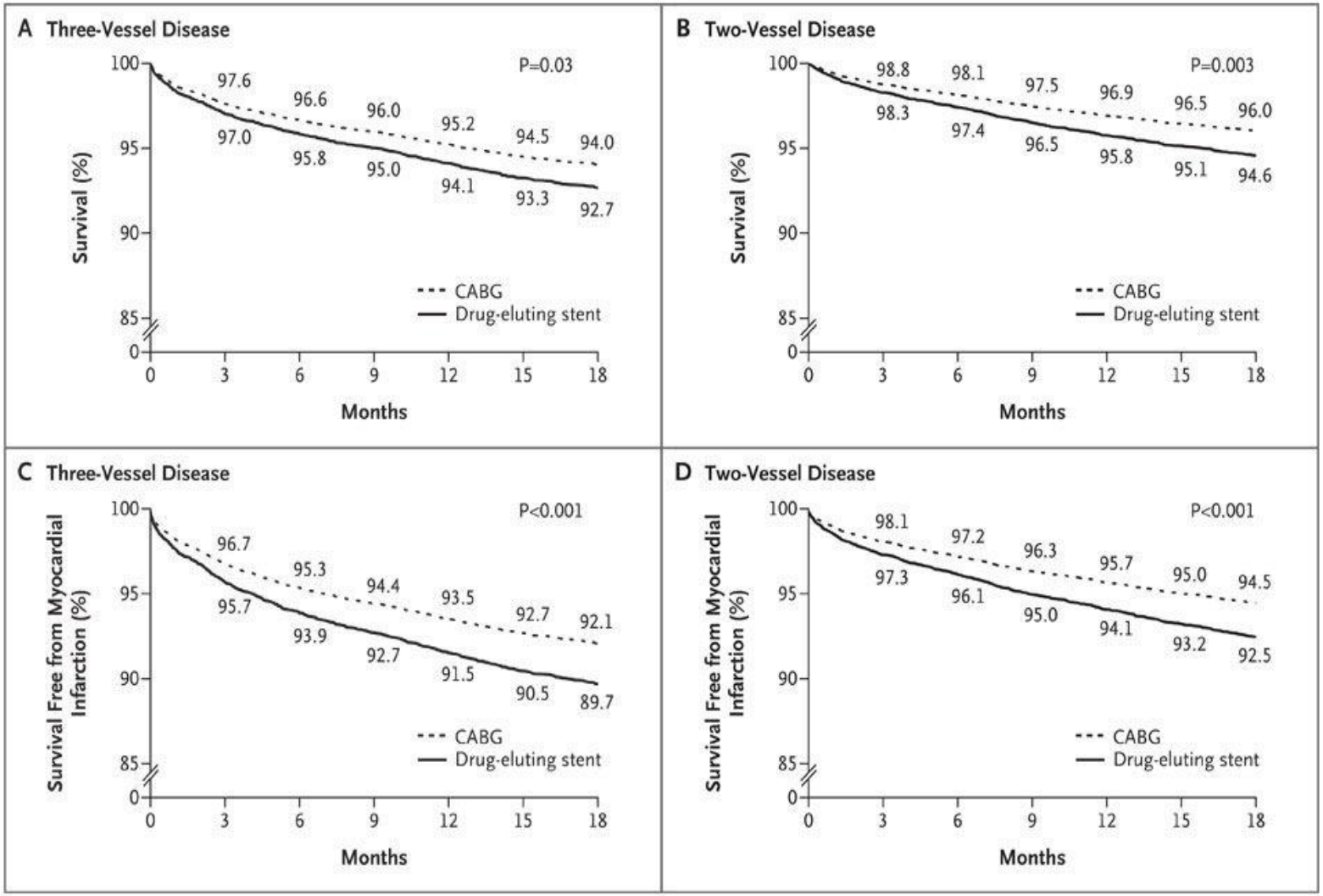
Adjusted Curves for Long-Term Survival and Survival Free from Myocardial Infarction According to the Number of Diseased Vessels



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Hazard Ratios for Death and for Death or Myocardial Infarction after CABG and after Treatment with a Drug-Eluting Stent, According to Selected Subgroups of Patients

Table 3. Hazard Ratios for Death and for Death or Myocardial Infarction after CABG and after Treatment with a Drug-Eluting Stent, According to Selected Subgroups of Patients.*

Variable	No. of Patients	Mean Follow-up	Death			Death or Myocardial Infarction		
			No. of Events	Adjusted Hazard Ratio (95% CI)†	P Value	No. of Events	Adjusted Hazard Ratio (95% CI)†	P Value
		mo						
Diabetes								
CABG	2844	18.9	242	0.97 (0.77–1.20)	0.75	304	0.84 (0.69–1.01)	0.07
Stent	3256	18.5	224	Reference		343	Reference	
Ejection fraction <40%								
CABG	1614	18.6	181	0.77 (0.59–1.00)	0.05	213	0.67 (0.53–0.84)	<0.001
Stent	1059	17.8	144	Reference		183	Reference	
Age ≥80 yr								
CABG	760	18.0	107	0.74 (0.55–1.00)	0.05	125	0.74 (0.56–0.96)	0.03
Stent	1266	17.8	175	Reference		216	Reference	

* CABG denotes coronary-artery bypass grafting, and LAD left anterior descending.
† Hazard ratios are adjusted for age; sex; ejection fraction; hemodynamic state; history or no history of myocardial infarction before procedure; presence or absence of cerebrovascular disease, peripheral arterial disease, congestive heart failure, chronic obstructive pulmonary disease, diabetes, and renal failure; number of diseased vessels; and involvement of the proximal LAD artery.

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Topics of Other Recent Studies

- Assessment of hospital and physician quality
- Examination of the volume-mortality relationship for cardiac procedures
- Access to cardiac procedures by race and gender
- Differences in utilization of cardiac procedures by region of the state
- Comparison of outcomes for different types of drug-eluting stents
- Comparison of off-pump and on-pump CABG surgery
- Examination of the impact of temperature and hematocrit on CABG surgery outcomes
- Study of the combined impact of onset-to-door time and DTB time on PCI outcomes for STEMI patients
- Evaluation of timing of non-target vessel PCI for STEMI patients
- Development of model to assess risk-adjusted mortality for pediatric cardiac surgery
- PCI vs. medical therapy for stable CAD (in progress)
- Outcomes for aortic valve replacement
- The impact of incomplete revascularization for PCI
- Evaluation of methods for risk-adjustment
- Comparison of utilization of cardiac procedures in NY and Ontario
- Onsite vs. Offsite CABG surgery backup for STEMI patients undergoing PCI
- Readmission rates for PCI

Comparison with National Registries (STS, NCDR)

	CSRS/PCIRS	STS/NCDR
Completeness (all cases reported)	Matched against NYS admin. data	???
Accuracy of risk factor Reporting	Data audited and matched against admin. data	???
Accuracy of outcomes	Data matched against admin. data and vital stat. data	???
Linking to other Databases	Vital stat, NDI, across cardiac registries, SPARCS, Medicare, Medicaid	Medicare Other?
Size, detail provided on forms	Less data elts, detail	More data elts, detail